## REMARKS ON THE SUBJECT OF FORCE IN GENERAL.

BY JOHN A. ROEBLING.

[For the Scientific American.]

[Concluded from page 141.]

The greatest mechanical effect results from impact, which is simply an aggregate of developed momenta. In impact the whole force is spent. The value of impact is equal to the mass multiplied by the square of velocity. A chemical explosion results from an instantaneous discharge of the whole pent-up force. The whole energy which is asleep in gunpowder, is roused into simultaneous action. The more instantaneous this development the greater its effect. This effect now is due to the rapidity of motion with which the aggregate massiveness flies apart into atoms. The heat which is rapidly developed in the combustion of powder, converts its solid particles into highly elastic vapors, whose weighty atoms repel each other with immense energy, and whose aggregate force is to be rated like impact by the square of velocity multiplied by the massiveness of the gases.

Only that is considered a natural effect or phenomenon which is experienced in some way by our senses. How an apparent nothing may suddenly become a very severe reality, nature sometimes illustrates very forcibly. For instance, common atmospheric air, when at rest makes no impression upon our senses. Ordinarily such air is nothing to human sense. But let the principle of motion act upon the apparent nothing, and see what a mighty power has suddenly sprung up. Air, moving at a rate of 3 miles per hour, produces a pleasant breeze; at 10 miles per hour, it becomes a high wind; at 30 miles per hour a strong gale will be experienced; but at 80 miles per hour a hurricane will sweep along whose terrific force will demolish massive buildings, uproot the stoutest trees, and level to the ground forests whose growth has consumed centuries! These terrible phenomena, which are of frequent occurrence, very plainly teach the important fact, that by the element of time alone—that is, velocity—the thinnest, lightest and most attenuated substance in nature may be transformed into a terrible medium of destructive energy. Because these things are matters of daily experience, they are seldom reflected upon.

A velocity of 80 miles an hour is equal to 1 mile in 45 seconds, or 0·02222 . . . miles in 1 second. But how small is this velocity, when compared to the speed of electricity, of light, or of thought, which is spiritual motion? Light is known to move at the rate of 195,000 miles in one second, which is 8,775,877 times the velocity of a hurricane moving 80 miles an hour. Suppose now the velocity of air increased to 195,000 miles per second, then the impact or total energy of this force would be to the energy of a hurricane $1^2 \div 8{,}775{,}877^2 = 1 \div 77{,}016{,}000{,}000{,}000$. The energy of force, therefore, resulting from the velocity of light, imparted to air, would be more than 77 million of million times as great as the energy of a hurricane. And invariably we are authorized to conclude, that an ethereal substance, moving 195,000 miles per second, will produce the same mechanical effect, as a hurricane, provided this ether is 77 million of million times as light as is atmospheric air.

The object of the above calculations is not to institute a comparison between the nature of the motion of air and of light, but simply to point out the great importance of the element of speed or of time. Nature's internal silent actions are produced by motions of inconceivable rapidity, so great that they are invisible to observation. And in the same ratio as the square of velocity of these movements *increases*, may the massiveness or weight of the moving substance be *decreased*. It is known that the impingement of the particles of air, when moving at hurricane speed, and acting upon each other, and upon other substances, produce friction, heat and electricity. When acting upon the exposed rocks and metals of the mountains, the same force will disintegrate them and carry them along through the atmosphere. But how much more potent is not the energy of lightning. The friction of the air produces intense heat and light, phenomena which accompany every stroke of lightning.

Electric action is an inner dynamic process, by which matter is moved, transformed, and energy produced. The principle of motion is *uncreated*, it can therefore only be communicated or transmitted from one substance to another substance or from one process to another process. But to transmit or communicate, requires a medium, and this medium is ether, the universal substance which permeates all natural substances and fills all space. If a suspended piece of iron is attracted by a magnet, the attractive force acts through the medium of ether. By the process of magnetism the peculiar magnetic motion is communicated from one particle of ether to another, and these transmitted energies, which result from the mutual action of the two bodies, overcome the gravitating tendency of the iron.

The motion of light is 195,000 miles per second. But this is only the outer velocity of motion, which communicates energy from one particle of ether to another. Light is not a substance, but only the effect of luminar energy. The internal spiral motion, which may be the inner cause of the outer motion, may result from a velocity of which we have no conception.

Human thought is elaborated in the human brain by a material process, which is matter in motion. As repeatedly said, the principle of motion in itself is nothing, in a natural sense; it becomes a reality only through the massiveness, the inertness of matter. Every man is conscious of the reality of his own thoughts; all men possess the faculty to project their thoughts instantaneously to the most distant regions, and to dwell in thought at the very confines of the universe. This is actual motion, whose rapidity is beyond calculation. The speed of mental light far surpasses that of physical light. And from this we infer, that the ether al medium, through which outer light is transmitted from star to star, must be much denser than the more interior spiritual essence, which conveys the flashes of the human brain.

There always have been two more or less distinct schools of philosophy, known as the *material* and the *spiritual*. The material school of the present day maintains that the final cause of motion, of energy, of life, resides in the elements of matter; and that by the combination of these elements all complex structures and organisms of nature are built up. The other school admits this view, as a matter of fact, but at the same time insists upon a spiritual principle, which pervades all matter, and which is the final cause of motion and of creation. Although some of the most successful experimental philosophers, and some of the first physiologists of the present age, advocate the pure material hypothesis, yet when the arguments and facts of both sides are calmly balanced, the unprejudiced mind, which only cares for truth and nothing for authority, will unhesitatingly embrace the spiritual philosophy, as the only one, which does rationally account for life and existence.

The advocates of pure materialism object to the idea of a *Final Cause*, yet Auguste Compte, in order to introduce some unity into chaos, was laboring hard to find out some sort of primary cause, which governs the harmony of the whole, and he accordingly pointed out, that gravitation perhaps might answer that purpose. But there are hosts of great men in continental Europe, living and teaching, as for instance the excellent Prof. Moleshott, now at Turin, who consider it entirely beneath themselves, to look for any such primary cause. In fact, then, men do only *indirectly* acknowledge the *unity* of nature, because if they did *directly*, they would be *forced* to look for some *central cause*, to which this *unity* refers, and from which it proceeds. To say that 65 or 70 chemical elements possess a natural instinct, which makes them act according to law, and that all processes of nature are governed by their inherent affections and lawful tendencies of matter, leaves us only to wonder and to guess where these miraculous laws come from? Nor does this view explain why all these apparently incongruous materials and agencies behave in such *perfect* accord and unison, that the grand objects of creation, its growth and development are accomplished; nor why the motions of the whole immensity proceed according to rigid and invariable mathematical principles? Where did the idea, this law of mathemetics, originate? Which is prior or first—the idea or its application? Did the scientific plan of the universe originate in the 65 chemical elements? Or were these elements constituted according to those ideas, and instinctively endowed with scientific tendencies, in certain well defined channels, and for certain well understood and *pre-ordained* and fixed purposes and ends?

The science of mathematics, in its largest sense, is the science of space and time, consequently it is the science of material creation; all other sciences refer to it and are built upon it. There can only be one true *abstract* science, and this is the science of mathematics. Other sciences are only collections of systematized experiences and observations, without any abstractions. But *before* that immense *abstract* science which *does* regulate and govern the universal process of material existence, could be spontaneously evolved as a *material* demonstration, the Great Mathematician, the Great Central Brain of the Universe, had to exist! The science of mathematics is simply a spontaneous outflow from the Central Source of Life, and this spiritual out-flow has manifested itself in mathematical forms and motions through the vehicle of matter. Pure materialism is a growth of human self-conceit, while simple truth will always tend toward a divine Central cause!

## HIGH AND LOW STEEL.

We extract the following remarks on this subject from "Holley's Ordnance and Armor:"—"By high steel is meant that which contains a large amount of carbon, and consequently low specific gravity. Its distinguishing properties are extreme ultimate tenacity, hardness, and capability of extension without permanent change of figure; but its extensibility beyond the elastic limit is small, and it is therefore brittle under concussion. It will harden when heated and immersed in water; it is with difficulty welded, because it deteriorates under high heat, and because its welding heat is so very near its melting point; and it is melted at a low temperature as compared with wrought iron.

"Its obvious defect for guns is its brittleness; but if so large a mass is used that its elastic limit will never be exceeded; or if it is jacketed with a less extensible metal, this defect is remedied or modified. Low steel, however, is a more suitable metal for canno, according to present tests.

"Low steel, also called 'mild steel,' 'soft steel,' 'homogeneous metal,' and 'homogeneous iron,' contains less carbon and has a higher specific gravity; it can be welded without difficulty, although overheating deteriorates it, and it more nearly resembles wrought iron in all its properties, although it has much greater hardness and ultimate tenacity, and a lower range of ductility, depending on its proportion of carbon. It has less extensibility within the elastic limit than high steel, but greater extensibility beyond it; that is to say, greater ductility.

"The grand advantage of low steel over wrought iron, for nearly all purposes, is, that it can be melted at a practicable heat and run into large masses; thus avoiding the serious defect of wrought iron in large masses—want of soundness and homogeneity. Its other important advantages for cannon are, greater elasticity, tenacity and hardness.

### ELASTICITY AND DUCTILITY.

"Mr. Anderson, Sir William Armstrong, Mr. Mallet, and others, complain, in various public statements, that most of the steel they have experimented with for guns is too brittle—that it gives way under *sudden* strains, which wrought iron will stand. Hence steel, especially high steel, has been condemned as a cannon metal.

"In answering this objection let us briefly review what has been said under the head of 'ductility.' Suppose two thin tubes of equal size, one of high steel and the other of wrought iron, to be subjected to the violent and sudden strains of gunpowder. The elastic limit of the steel is overcome, and it soon breaks, because it has but a small reserve of ductility to draw upon, to eke out its integrity. The elastic limit of the wrought-iron tube is overcome much sooner, but it has an immense capital of ductility to expend, and so it stretches and stretches for a long time without fracture.

"Now suppose the quantity—thickness of steel to be increased just so much that the pressure—proof charges, for instance—will never overcome its elastic limit, that is to say, so that its particles will return to their original position after the pressure ceases. Its original resistance to the next strain is then unimpaired, and there is no evidence that it will ever become impaired ; for elasticity is simply the antagonism between two tireless and changeless forces—repulsion by heat, and the attraction of cohesion.

"But in order to bear the same pressure (and the demand is for the highest possible pressure of powder), the iron, equally increased in quantity, will stretch beyond its elastic limit, and therefore must depend upon a new arrangement of particles and a new limit of elasticity for continued cohesion. Its great ductility allows this re-arrangement to continue for some time; but although it may stretch to a less distance at each renewed application of the pressure, its ability to stretch and its range of elasticity are constantly diminishing, until it at last arrives at a point where it can stretch no further without fracture. It has exhausted its reserved ductility. If it were not so, iron would never be broken at all by stretching. In addition to this, although a given area of stretched iron may sustain more than the same area of the original metal, the total area is constantly diminishing. It is, to a great extent, a substitution of a little strong iron for much weak iron. In order to endure *as long* as the steel, the iron must be still greater in quantity, because the 'work done' to raise it to its limit of elasticity is less than that required to raise steel to its limit of elasticity.

"This explains the failure, after short service, of thin tubes made of the moderately high steel heretofore used, while thin iron tubes *appear* to be unimpaired by elongation, although they certainly are impaired from another cause—compression. It is simply a question of excess of metal and, practically, endless endurance, on the one hand, and ultimate failure on the other hand.

"The serious mistake in the use of the steel heretofore obtained, for extreme charges of powder, appears to have risen from the neglect of the whole subject of the elastic and the ductile limits. Because the *ultimate strength* of steel was higher than that of iron, the quantity of the material has been proportionately reduced, when its quantity should have been proportioned to the work done in overcoming its resistance to extension.

"If steel, or any metal requiring the highest attainable effort of force in motion to stretch it *within* its elastic limit, could also be made to have a great range of ductility beyond it, the safest and most perfect cannon-metal would be obtained. But unfortunately, as the one property increases the other decreases. Low steel, the amounts of metal being the same in each case, would stand more pressure than iron within the elastic range, and would stand sudden strains longer than high steel; but its elastic limit once exceeded, from any cause, it would fail sooner than wrought iron. As a compromise between high steel and wrought iron, it has this advantage, that a small increase of weight of material will be a considerable increase of pressure, within the limits of safety.

"But according to Mr. Kirkaldy's experiments, the lower steels have a considerable degree of extensibility before fracture, and so much tenacity that the work done in stretching them to rupture actually exceeds that required to rupture the best wrought iron."

### An English Operative in an American Factory.

A Sheffield cutler, working in one of our Eastern factories, wrote to his comrades at home stating his views of our workshops, etc. We make an extract from his letter. The remarks about the division of labor indicate a lack of knowledge. It is practiced more extensively here than elsewhere, and our manufacturers were the first to institute regularly organized plans for accomplishing specific objects.

The great number of large works—cotton, woolen, edge-tools, files, table knives, indeed all kinds of trade—carried on, and in a first-rate style, too, will soon enable them to compete with England for the markets of the world. Look out, you at home; go ahead, or the Yankees will trip you up in trade matters. I don't think they could compete with you yet in their own markets but for their tariff. They have not got the division of labor amongst the materials, as you have; they have not the iron and coal, and the material trades so concentrated as you have, and then, from the demand for labor, don't work for so little as you do. Steel comes from one distant town; tip handles from another; coals and bone handles, wire tools, etc., etc., from others. Ivory in tusk is six dollars a pound. They do far more with machinery in all kinds of trades than you. Men never learn to do a knife through, as they do in Sheffield. The knives go through thirty or forty hands. One matches and resins all; another pins all; another bores all handles; another glazes all blades, and another buffs all handles. I myself glaze and chill all the better knives they make at Hanover Works, and nothing else, from day to day. If a Yankee can resin a knife on, they call him a cutler; and by doing one thing all the time they become very expert, and make some very good knives. Not the variety you make, but such patterns as are done easiest by machinery, and there is a large quantity made, I assure you. The Englishmen get the best wages, because they can go to any part of a knife, and the Yankee don't like it. The system of managing here is for one man to be responsible for the forging of blades. All are made by trip hammers. He is a practical man, able to mend tools and see all the machinery is in order; he is called the 'boss blacksmith.' Another attends to the grinders and sees that the blades are properly done, and the orders attended to. Another attends to all the steel forks. The last came from Sanderson's, Carver street, Sheffield; [the former, doubtless; not the forks, certainly;] he attends to all the hands engaged on forks. Then the work we call hafting is let to a job hand who employs all the men he needs to put the work through. He takes the job at so much the hundred. All are reckoned by the hundred here, and are taken, carvers, tables and desserts, at one price, in most cases; but grinding and less carvers get the better above all these bosses. There is what you call a table knife manager who gives out the materials as toe come in to those they belong to, sees they are finished right, and to whom the superintendent refers all letters and information as to what is wanted, and he sees that the things wanted are attended to and put through. The superintendent is the head 'boss' over the men, lets the jobs, sets the price, turns off and sets on, and keeps a few hands always at liberty to go from job to job when needed; and these are called 'company hands.' All are Englishmen, who know how to go at any part of a knife, for the Yankees are brought up to one or two jobs and cannot shift about. Men who have jobs, matching and resining, for instances, set on and turn off their extra hands as they like, and if any of them are stuck with their work, the 'company's hands' are sent to help them out, and he has to pay them after the rate the company pays. They work by the hour. I am a 'company hand,' so is Joseph H———, and H. B———. The superintendent is responsible to a board of directors, elected by the company, who are shareholders. Nearly all the works here are shareholding concerns, and there is such smashing up amongst these companies! The shareholders differ from the managers, the managers get experience and set up for themselves, or demand nearly all the profits. The orders are not sent direct to the works, but they have agents or sale-shops at New York and other places, who send the orders and keep, if possible, their shelves fully supplied with trashy articles. The people here are far more steady than in Sheffield. Men seldom go off drinking here. There are no 'bull weeks,' and no holiday at the Christmas time unless you take it. The works were not stopped one hour this Christmas. There are no beggars here; all seem very well off, and far better dressed than working men in Sheffield, and far cleaner. The methods of working are far easier; indeed, the Yankees will not do hard work, if possible. There are not as many files used among 200 men as you could put in your pocket.

[There are some funny statements here, and some that are quite incredible.—Eds.

### Remedy for Scale in Boilers.

We have been shown a large fragment of some foreign matters which had been deposited on the boiler of the steamer *Bowman*. This scale was removed by "Temple's Liquid," a preparation for the object in question now much used in different parts of the country. It is stated that this article is a perfect remedy for the trouble, and is guaranteed to give satisfaction in all cases. Attention is directed to an advertisement in the usual place.

### Shells and Beaver Skins for Money.

Amongst the objects of natural history and ethnology brought from British Columbia and Vancouver's Island by Mr. J. K. Lord was a belt composed of numerous specimens of a species of *Dentalium* strung together.

"It is somewhat curious," observes Mr. Lord, "that these shells (*Entalis pretiosus*, Nuttall sp. *Entalis vulgaris ?*) should have been employed as money by the Indians of North-West America—that is, by the native tribes inhabiting Vancouver's Island, Queen Charlotte's Island, and the mainland coast from the Straits of Fuca to Sitka. Since the introduction of blankets by the Hudson Bay Company, the use of these shells, as a medium of purchase, has, to a great extent, died out, the blankets having become the money, as it were, or the means by which everything is now reckoned and paid for by the savage. A slave, a canoe, or a squaw, is worth in these days so many blankets; but it used to be so many strings of *Dentalia*. In the interior, east of the Cascade Mountains, the beaver skin is the article by which everything is reckoned—in fact, the money of the inland Indians.

"The value of the *Dentalium* depends upon its length; those representing the greater value are called when strung together, end to end, a 'Hi-qua'; but the standard by which the *Dentalium* is calculated to be fit for a 'Hi-qua' is, that twenty-five shells placed end to end must make a fathom, or six feet in length. At one time a 'Hi-qua' would purchase a male slave, equal in value to fifty blankets, or about $250. The shorter and defective shells are strung together in various lengths and are called 'kop-kops.' About forty 'kop-kops' equal a 'Hi-qua' in value. These strings of *Dentalia* are usually the stakes gambled for. The shells are generally procured from the west side of Vancouver's Island, and towards its northern end; they live in the soft sand in the snug bays and harbors that abound along the west coast of the island, in water from three to five fathoms in depth. The habit of the *Dentalium* is to bury itself in the sand, the small end of the shell being invariably downwards and the large end close to the surface, thus allowing the fish to protrude its feeding and breathing organs. This position the wily savage has turned to good account, and has adopted a most ingenious mode of capturing the much-prized shell. He arms himself with a long spear, the haft made of light deal, to the end of which is fastened a strip of wood placed transversely, but driven full of teeth made of bone, resembling exactly a long comb with the teeth very wide apart.

"A squaw sits in the long stem of the canoe and paddles it slowly along, whilst the Indian with the spear stands in the bow. He now stabs the comb-like affair into the sand at the bottom of the water, and after giving two or three stabs draws it up to look at it; if he has been successful, perhaps four or five *Dentalia* have been impaled on the teeth of the spear. It is a very ingenious mode of procuring them, for it would be quite impracticable either to dredge or net them out, and they are never, as far as I know, found between tide-marks.

"At one period, perhaps a remote one, in the history of the inland Indians, these *Dentalia* were worn as ornaments. I have often found them mixed with stone beads and small bits of the nacre of the Haliotis, of an irregular shape, but with a small hole drilled through each piece, in the old graves about Walla-walla and Colville. In all probability these ornaments were traded from the coast Indians; but as these graves were quite a thousand miles from the sea, it is pretty clear the inland and coast Indians must have had some means of communication."—*Technologist.*

### Slow and Sure.

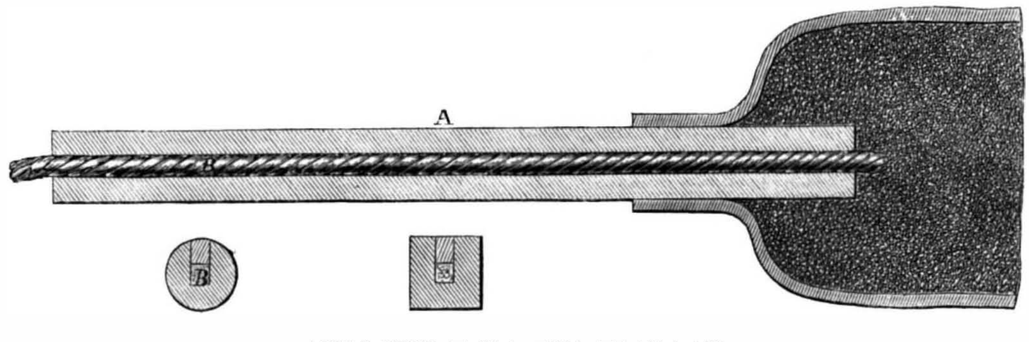
Mr. Thomas Cook, correspondent of the New York *Herald*, writes as follows from Fort Fisher:—

"The enormous shells of the monitor were thrown with unerring precision at so short a range, every one exploding with effect. Not a shot was wasted from this vessel. Although she fires but slowly, she accomplishes infinitely more in attacking such a work than all the rest of the fleet combined. With her it is a perfect matter of indifference whether the fort responds or not; and at every discharge cartloads of sand are shoveled out of the wall of the fort."

### Fuse for Blasting.

Blasting coal in dry situations has been performed in the anthracite coal regions of Pennsylvania mostly by the needle--a round piece of iron or copper, from three to five feet long, tapering from five-eighths of an inch to a point. The needle is inserted in the cartridge or charge of powder, to the depth of a few inches, when the powder is pushed to the extremity of the hole which is tamped by moistened fine coal to its mouth. The needle is then drawn and a squib and match are fixed in the space occupied by the needle, by which means the charge is exploded.

In wet situations, where feeders of water are cut by the drill hole, an iron tube is resorted to. This tube is made from three to four feet long and about a quarter of an inch in diameter. To use the tube, a water-proof cartridge is made on a proper former. The cartridge is charged with powder within a few inches of being full. Before the upper end is closed the tube is inserted and secured by means of a piece of string which wraps the end of the cartridge over the end of the tube in such a manner as to make a water-tight joint. The tube and cartridge are then placed in the drill hole and tamped; the charge is exploded by means of an ignited squib running through the tube. Simple as these modes of blasting appear they are open to serious objections. With the needle the hole is apt to collapse after the needle is drawn, or the charge liable to be prematurely ignited by the friction occasioned by the operation of tamping, or of drawing the needle; the lives of the miners are then in imminent danger. The danger is not so great in using the tube, but it has the disadvantage of being unwieldy; and when the veins dip at the rate of 40° and upwards, as they very often do, if the barrel is not chained it is blown away down the excavation among the loose coals where it is not safe for the miner to search for it. And in more favorable instances, where the tube is found it is often bent like an S, or perhaps broken in two or three parts, when a new tube is necessary. In a strong coal a tube does not often fire more than half a dozen blasts. Sometimes when chains are used to secure the tubes, the blasts force both chains and tubes into the breast when all are lost, costing together almost as much as a miner's day's work is worth. And when the chains hold on to the tubes they often have to be dug out from under tuns of loose coal.



WALTON'S FUSE FOR BLASTING.

To avoid all this unnecessary labor and to render the operation of blasting more safe, an improved safety fuse has been invented and is here shown, it may be used in coal as in rock. The fuse resembles a case of wood, A, about three-eighths of an inch thick, either round or square, and of any desirable length. Within the case is a train of powder, a small piece of fuse made in the usual way, or a small thread of guncotton. The combustible material, B, is laid along a groove cut in a piece of wood and then covered over by oakum and pitch or any water-proof material to protect it from the action of moisture. In case of gun-cotton being used a piece of wood is fitted into the upper part of the groove and secured there by glue. The whole outer surface is covered by a coat of pitch and tar to make the fuse water-proof. This fuse is not only intended to be used as a substitute for the iron tube in blasting coal, but also in rock, where, owing to the protecting case, the train will not become detached by the cutting of the fuse. The invention was patented through the Scientific American Patent Agency, Jan. 3, 1865, by Thomas H. Walton, of Ashland, Pa. Further particulars can be had by addressing the inventor.

### Water-proof Cement.

Mr. Joseph Schofield, of Wappelo, Iowa, writes us that he makes a valuable water proof cement by the following recipe:

Take new sweet cheese and work it in hot water until the butter or greasy portion is all removed. This changes the cheese into a tenacious slimy mass. When thoroughly washed, remove the cheese to a hot stove, and knead a quantity of air-slacked lime in so that the mass will be sufficiently stiff for use. It must be applied forthwith as it sets rapidly. The articles to be joined must be heated quite hot, as high as 200°, or scalding water, then united and bound so they will remain in contact until set; in about three days the articles may be used. It is said that this cement is capital for aquaria; also for wood, glass and stone, or earthen ware. Mr. Schofield states that he has tried it on a steam boiler and that he made a "soft patch," so called by boiler makers, with great success.

As the materials from which this cement is made can be had any where in rural districts, it will be well for engineers and housekeepers to bear it in mind.

### RUDOLPH & KASEFANG'S BRUSH HANDLE.

Iron castings when taken out of the sand have a large portion of the same adhering to the rough sides, and many men get a living by cleaning off this sand so as to render the castings fit for use. The instrument they employ for some parts of the work is a wire brush. Convenient lengths of wire are taken and doubled over and bound together; the free ends of these wires form the brush, and is used as any other utensil of its kind. These brushes can be used up to the handle, but that portion which is grasped, must be thrown away when the brush part is worn up short, so that quantities of wire are thus wasted, which ought not to be.

Fig. 1.

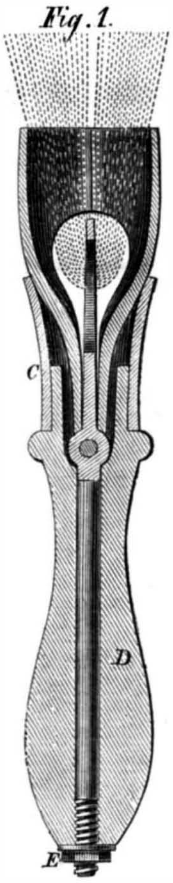
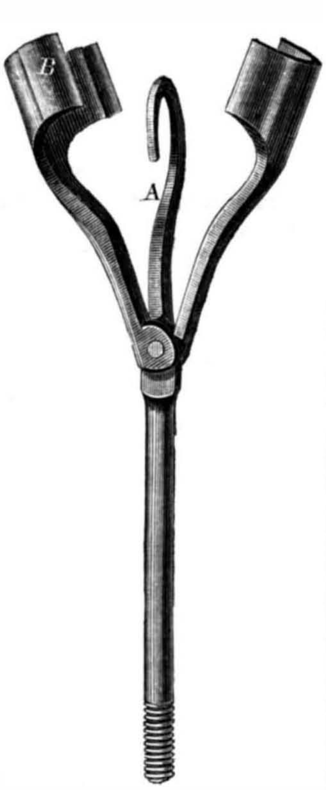


Fig. 2.



The object of the handle illustrated in Figs. 1 and 2 of the engraving is to hold the wires firmly and cause little or no waste in material. The wires are turned over the hook, A, as shown by the dotted lines in Fig. 1, and then bound by the clamps, B. These clamps are hinged and the ferule, C, holds them both firmly closed. The handle, D, is removed by taking off the nut, E, when the brush is to be renewed.

This arrangement gives a firm support to the wires and a most convenient handle to the brush, while it is far more economical than the present brushes for the purpose. It was patented through the Scientific American Patent Agency, on the 29th of November, 1864, by Fred. Rudolph and William Kasefang; for further information address them at 21 Essex street, Jersey City, N. J.

### A Peculiar Wages Arrangement.

In the last number of the *Technologist* there is a description of a sugar refinery in Bengal which closes with this statement:—

"Lastly. We may remark that the wages of every *employe* in the Cossipore factory, from the head boiler down to the coolie, who carries the bags of sugar (weighing nearly two cwt.) to the export warehouse—that all these wages are calculated according to the production of manufactured sugar during the month. The result is, that every one works with a sense of self-interested alacrity, which would astonish some of those complacent Englishmen who regard the Hindoos as a set of lazy, lethargic barbarians.

### A PRACTICAL PLAN FOR DESTROYING THE SPAN WORM.

On Tuesday evening, Feb. 21, Dr. Trimble, of Newark, N. J., the well known naturalist, delivered a lecture before the Horticultural Association, at the American Institute, on the span worm, or measure worm, that is so destructive to the shade trees of this city. Though the lecture occupied more than an hour in delivery, it was listened to by the large audience present with quiet interest from beginning to end. The success of Dr. Trimble in securing and holding the attention of a promiscuous audience for so long a time on the subject of a single worm is attributable partly to his own interest in the subject, and partly to the happy plan of giving his lecture the narative form. He read a diary of his observations throughout the season of the insect's life.

#### THE EGGS.

The lecturer first exhibited a handful of branches on which were large numbers of eggs, and called attention to the fact that the eggs were nearly all on the lower sides of the limbs. He stated that no degree of cold injured the eggs, but that when ice collected on the branches it was sometimes fatal to them.

#### WONDERFUL INSTINCT OF THE MOTHER.

The diary commenced with the coming forth of the leaves on the 8th of May. The degree of warmth that is necessary to bring forth the leaves is also just the degree that is required to hatch the eggs. The mother knew this last July when she deposited her eggs, and therefore selected those trees which would put forth their leaves at the same time that the eggs would hatch.

"It may be asked, How do these little feeble, fluttering things know which are the right trees? I can not answer. We call it instinct. But what is instinct? It is a word we use to answer a question, but it is not a definition. The insect world is full of such wonders. They are the manifestations of the guiding hand of God Almighty."

#### JARRING THE TREES.

"June 9. Visited Brooklyn to-day to see the worms. At one place I saw a negro man with a pole some 20 feet long, with a cross piece about six inches in length fastened to one end of it; and with this he was jarring the 'critters', as he called them. He was the most sensible man I have ever met with on the worm question. He jarred and jarred, and I picked up till I got my handkerchief full, and then he killed the remainder."

#### THE CEDAR BIRD.

"Later in the day, after a shower, I visited Madi-